Mark Scheme (Results)

Summer 2018

Pearson Edexcel
International Advanced Level
in Physics (WPH05)
Paper 01 Physics from Creation to Collapse

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'

1.2 Bold lower case will be used for emphasis e.g. '**and'** when two pieces of information are needed for 1 mark.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will mean that one mark will not be awarded. (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Communication

5.1 Indicated by QWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

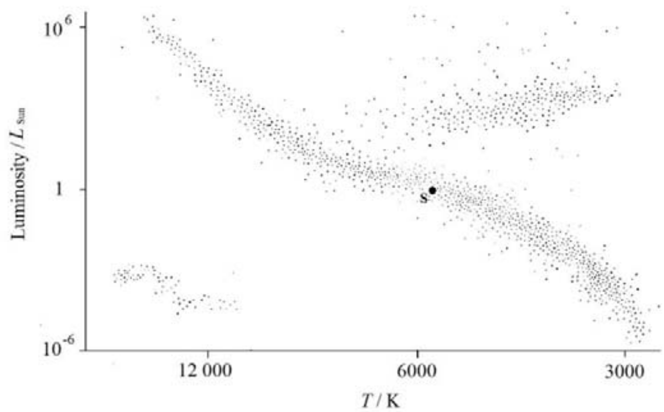
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	The only correct answer is **D** A is not correct because this is not true for an open universe B is not correct because this is not true for an open universe C is not correct because this is true for a closed universe	**1**
2	The only correct answer is **D** A is not correct because the energy is proportional to the amplitude squared B is not correct because the energy is proportional to the amplitude squared C is not correct because the energy is proportional to the amplitude squared	**1**
3	The only correct answer is **B** A is not correct because dark matter does not interact with electromagnetic radiation C is not correct because the opposite is true for dark matter D is not correct because dark matter provides no direct evidence for the Big Bang	**1**
4	The only correct answer is **B** A is not correct because at the same temperature, the average kinetic energy is the same all molecules C is not correct because mass of H_2 molecule < mass of He molecule D is not correct because mass of H_2 molecule < mass of He molecule	**1**
5	The only correct answer is **C** A is not correct because although this is a true statement it is not the reason B is not correct because although alpha particles are relatively massive it is not the reason D is not correct because it is not true for alpha particles	**1**
6	The only correct answer is **D** A is not correct because the temperatures have not been raised to the power 4 and the resultant ratio has been inverted B is not correct because the temperatures have not been raised to the power 4 C is not correct because Stephan Boltzmann law has not been applied	**1**
7	The only correct answer is **C** A is not correct because $L \propto Fd^2$ B is not correct because $L \propto Fd^2$ D is not correct because $L \propto Fd^2$	**1**
8	The only correct answer is **A** B is not correct because an incorrect distance 2r has been used C is not correct because 3r has been used but not squared D is not correct because an incorrect distance 2r has been used and not been squared	**1**
9	The only correct answer is **C** A is not correct because both statements are incorrect B is not correct because the mean molecular kinetic energy stays the same D is not correct because the mean molecular potential energy increases	**1**
10	The only correct answer is **D** A is not correct because there may be sufficient radiation flux B is not correct because the luminosity may be sufficient C is not correct because the angle decreases as the distance increases	**1**

Question Number	Answer		Mark
11(a)	Use of $v = f\lambda$ λ = 0.12 m <u>Example of calculation</u> $\lambda = \frac{3\times10^{8}\text{m s}^{-1}}{2.45\times10^{9}\text{ s}^{-1}} = 0.122\text{ m}$	**(1)** **(1)**	**2**
11(b)(i)	Use of $\Delta E = mc\Delta\theta$ **and** use of $P = \frac{\Delta W}{\Delta t}$ Use of efficiency = $\frac{\text{useful energy output}}{\text{energy input}}$ **Or** use of efficiency = $\frac{\text{useful power output}}{\text{power input}}$ Efficiency = 0.75 or 75% <u>Example of calculation</u> $\Delta E = 225\times10^{-3}\text{kg}\times4190\text{ J kg}^{-1}\text{ K}^{-1}\times(67.5-15)\text{K}$ $= 4.949\times10^{4}\text{ J}$ Energy input = 550 W×120 s = 6.60×10^{4} J $P = \text{efficiency} = \frac{4.95\times10^{4}\text{J}}{6.60\times10^{4}\text{J}} = 0.750\text{ or }75.0\%$	**(1)** **(1)** **(1)**	**3**
11(b)(ii)	Not all the (microwave) energy is absorbed by the water **Or** some energy is transferred from the water to the surroundings **Or** not all the input energy is transferred to microwave energy [Do not accept heat for energy]	**(1)**	**1**
	Total for question 11		**6**

Question Number	Answer		Mark
12(a)	No <u>background count</u> taken [Accept count rate for count] No repeat readings **Or** record count for a longer period of time	**(1)** **(1)**	**2**
12(b)	Paper causes no (significant) change in count (rate), so there is no alpha radiation <u>1 mm</u> aluminium causes decrease in count (rate) so there must be some beta radiation Lead sheet reduces the count (rate) more than the 5 mm aluminium sheet does, so there must be gamma radiation **Or** 5 mm of aluminium should completely absorb beta radiation but there is still a (significant) count (rate) so there must be gamma radiation	**(1)** **(1)** **(1)**	**3**
	Total for question 12		**5**

Question Number	Answer		Mark
13(a)	Reverse scale	**(1)**	
	Power/log scale	**(1)**	**2**
			
	[MP2 Do not accept temperatures outside range 20 000 K→ 2500 K]		
13(b)	λ_{max} for the light emitted by these stars is smaller than for the Sun	**(1)**	
	$\lambda_{max}T =$ constant, therefore the (surface) temperature of these stars is higher than that of the Sun	**(1)**	
	$L = \sigma T^4 A$, so A is small for these low luminosity stars	**(1)**	
	For **Max 2** H-R diagram shows T for white dwarf > T_{Sun}	**(1)**	
	$L = \sigma T^4 A$, so A is small for these low luminosity stars	**(1)**	**3**
	[Accept peak wavelength for λ_{max}]		
	Total for question 13		**5**

Question Number	Answer		Mark
14(a)	The speaker forces/drives the surface/wood into oscillation So (a large volume of) air is set into oscillation by the surface/wood (increasing loudness of sound) MP2 dependent on MP1 [Accept table or floor for surface/wood]	**(1)** **(1)**	**2**
14(b)	The surface/wood is forced/driven into oscillation at/near its natural frequency **Or** The frequency (of the sound) is at/near the natural frequency of the surface Resulting in an efficient/maximum energy transfer **Or** resulting in a maximum amplitude of oscillation This effect is called resonance [Accept table or floor for surface/wood] [Do not accept speaker for surface]	**(1)** **(1)** **(1)**	**3**
	Total for question 14		**5**

Question Number	Answer		Mark
15(a)(i)	There is a Doppler shift The star is (alternately) moving towards and away from the Earth When the star is moving towards the Earth the wavelength (detected) is decreased **Or** When the star is moving away from the Earth the wavelength (detected) is increased [Accept Doppler effect for Doppler shift but not red/blue shift]	**(1)** **(1)** **(1)**	**3**
15(a)(ii)	Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ v = 469 m s^{-1} [Accept 470 m s^{-1}] <u>Example of calculation</u> $v = \frac{9.73\times10^{-4}\text{nm}}{622\text{ nm}} \times 3.0\times10^{8}\text{m s}^{-1} = 469\text{ m s}^{-1}$	**(1)** **(1)**	**2**

Question Number	Answer		Mark
*15(b)	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** **Either** A more massive star would have larger gravitational forces (tending to collapse the star) Hence the rate of fusion in the core would be greater Producing a higher/larger temperature (Dependent on either MP1 or MP2) **Or** **Max 2 marks** A more massive star would be higher up the main sequence on the Hertzsprung-Russell diagram Hence the temperature would be greater (Dependent on MP1)	 **(1)** **(1)** **(1)** **(1)** **(1)**	**3**

Question Number	Answer		Mark
15(c)	Less massive exoplanets would exert (much) smaller gravitational forces on the star **Or** For less massive exoplanets the centre of the orbit would be (much) closer to the star	**(1)**	
	Hence the change in wavelength would be small / undetectable (Dependent on MP1)	**(1)**	**2**
	Total for question 15		**10**

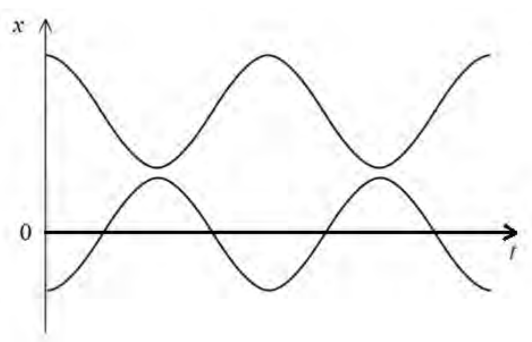
Question Number	Answer		Mark
16(a)(i)	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$ $\lambda_{max} = 1.1 \times 10^{-6}$ (m) <u>Example of calculation</u> $\lambda_{max} = \frac{2.898\times10^{-3}\text{m K}}{2630\text{ K}} = 1.10\times10^{-6}$ m	**(1)** **(1)**	**2**
16(a)(ii)	λ_{max} (the wavelength of peak power emission) is in the infra-red region of the spectrum **Or** λ_{max} (the wavelength of peak power emission) is longer than visible light (Hence) only some of the em-radiation produced by the lamp is in the visible region [Accept peak wavelength for λ_{max}]	**(1)** **(1)**	**2**
16(a)(iii)	Use of $pV = NkT$ Conversion of temperature to kelvin p = 88 kPa or 8.8×10^4 Pa <u>Example of calculation</u> $p_2 = \frac{(165+273)\text{ K}}{(18+273)\text{ K}} \times 58.5\text{ kPa} = 88.1\text{ kPa}$	**(1)** **(1)** **(1)**	**3**
16(b)(i)	Use of $F = \frac{L}{4\pi r^2}$ $L = 2.9 \times 10^{26}$ W <u>Example of calculation</u> $\frac{L_{Sun}}{4\pi\times\left(1.5\times10^{11}\text{ m}\right)^2} = \frac{200\text{ W}}{4\pi\times(0.125\text{ m})^2}$ $L_{Sun} = \left(\frac{1.5\times10^{11}\text{m}}{0.125\text{ m}}\right)^2 \times 200\text{ W} = 2.88\times10^{26}\text{ W}$	**(1)** **(1)**	**2**

Question Number	Answer		Mark
16(b)(ii)	**Max 2**		
	Lamp is inefficient so visible light luminosity < 200 W	**(1)**	
	It is hard to judge when the brightness of the spot and the rest of the card are the same	**(1)**	
	The distance from the lamp to card is small, so there is a large uncertainty in this measurement	**(1)**	
	Some of the Sun’s light is absorbed by the grease spot on the card **Or** Some of the Sun’s light is absorbed by the atmosphere	**(1)**	**2**
	Total for question 16		**11**

Question Number	Answer		Mark
17(a)(i)	The energy released when the nucleons form the nucleus **Or** The energy required to split the nucleus up into its constituent/separate/component nucleons (Accept protons **and** neutrons for nucleons)	**(1)**	**1**
17(a)(ii)	The fission/splitting of a massive nucleus increases the binding energy per nucleon, hence releases energy The fission/splitting of a light nucleus requires energy (as the binding energy per nucleon decreases) **Or** energy is only released for light nuclei if they are fused (to increase the binding energy per nucleon) [Do **not** accept small for light]	**(1)** **(1)**	**2**
17(b)(i)	Top line correct 122 Bottom line correct 44 <u>Example of calculation</u> $^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{111}_{44}\text{Ru} + ^{122}_{48}\text{Cd} + 3^{1}_{0}\text{n}$	**(1)** **(1)**	**2**
17(b)(ii)	Use of $\Delta E = c^2 \Delta m$ Δm = 3.6 × 10^{-28} kg (Allow Δm = 200 MeV/c^2) <u>Example of calculation</u> $\Delta m = \frac{3.2 \times 10^{-11}\text{ J}}{(3.0 \times 10^{8}\text{m s}^{-1})^2} = 3.56 \times 10^{-28}$ kg [Allow 3.55×10^{-28} kg for 2 marks] [An answer of 3.5×10^{-28} kg scores MP1 only]	**(1)** **(1)**	**2**

Question Number	Answer		Mark
17(b)(iii)	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** Electrostatic repulsion does occur between the nuclei because they both have positive charge **Or** neutrons will not be affected by electrostatic repulsion since they are uncharged The momentum before fission is zero / small (So) to conserve momentum all the fragments must move away from each other	**(1)** **(1)** **(1)**	**3**
17(c)	Use of $\lambda = \frac{ln2}{t_{1/2}}$ Use of $N = N_0 e^{-\lambda t}$ t = 61 years [1.9×10^9 s] <u>Example of calculation</u> $\lambda = \frac{\ln 2}{14 \text{ years}} = 0.0495 \text{ years}^{-1}$ $t = \frac{\ln(0.05)}{0.0495 \text{ years}^{-1}} = 60.5 \text{ years}$ [Use of 95% → 1.04 years scores MP1 and MP2]	**(1)** **(1)** **(1)**	**3**
	Total for question 17		**13**

Question Number	Answer		Mark
18(a)	(For simple harmonic motion the) acceleration is: • (directly) proportional to displacement from equilibrium position • (always) acting towards the equilibrium position **Or** idea that acceleration is in the opposite direction to displacement [accept undisplaced point/fixed point/central point for equilibrium position] **Or** (For simple harmonic motion the resultant) force is: • (directly) proportional to displacement from equilibrium position • (always) acting towards the equilibrium position **Or** idea that force is a restoring force e.g. "in the opposite direction" [accept undisplaced point/fixed point/central point for equilibrium position] [Do not accept mean position or equilibrium for equilibrium position] [An equation with symbols defined correctly is a valid response for both marks. e.g $a \propto -x$ or $F \propto -x$]	**(1)** **(1)** **(1)** **(1)**	**2**

Question Number	Answer		Mark
18(b)(i)	Use of $\omega = \frac{2\pi}{T}$ Use of $a = (-)\omega^2 x$ a_{max} = 0.94 m s^{-2} Example of calculation $\omega = \frac{2\pi \text{ rad}}{6.0 \text{ s}} = 1.05 \text{ rad s}^{-1}$ $a_{max} = -(1.05 \text{ rad s}^{-1})^2 \times 0.85 \text{ m} = -0.937 \text{ m s}^{-2}$	**(1)** **(1)** **(1)**	**3**
18(b)(ii)	[apply ecf from bi] Evidence of acceleration in terms of *g* Use of graph to conclude that it would be tolerable, so low chance of seasickness [A minimum of one point marked on the graph showing the point *T* = 6 s with their value of *a*/*g* and an appropriate comment] Example of calculation $\frac{a}{g} = \frac{0.93 \text{ m s}^{-2}}{9.81 \text{ m s}^{-2}} = 0.095$	**(1)** **(1)**	**2**
18(c)	Minus cosine curve with same period as displacement Variation centred about zero with constant amplitude  	**(1)** **(1)**	**2**

PMT

Question Number	Answer		Mark
18(d)(i)	2 correct forces with force arrows the same length *N* / *R* / reaction (force)  *W* / *mg* / weight [Do not accept upthrust for *R*]	**(1)**	**1**
***18(d)(ii)**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** The reading on the scales is equal to the reaction/contact force There is a restoring/resultant force towards the centre of the oscillation **Or** The restoring/resultant force changes direction (as the passenger crosses the equilibrium position) When the passenger is above the equilibrium position the reaction force is less than the weight of the passenger and so the reading is reduced [accept at the top for above…] **Or** When the passenger is below the equilibrium position the reaction force is greater than the weight of the passenger and so the reading is increased [accept at the bottom for below…]	**(1)** **(1)** **(1)**	**3**
18(d)(iii)	Use of Newton's 2nd law Reading on weighing scales = 80 kg [accept R = 790 N for both marks] <u>Example of calculation</u> At the lowest point, $R - mg = ma$ $R = m(a + g)$=75 kg ×(0.7+9.81) m s^{-2} = 788 N reading= $\frac{788\text{ N}}{9.81\text{ N kg}^{-1}}$ =80.4 kg	**(1)** **(1)**	**2**
	Total for question 18		**15**

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